reactors, internals and their auxiliary components), unless specialized metallurgy and/or other costly materials of construction are used. In either event, how the corrosiveness of the maleic acid is addressed in the commercial plant's design, procurement, construction, operation and maintenance has a major impact on process economics of a maleic acid to 1,4-butanediol chemical plant and hence its commercial viability. Applicants observed that maleic acid is very corrosive at temperatures exceeding approximately 140°C, but that at temperatures less than about 130°C, the corrosion was minimized. Other testing by Applicants confirmed that the hydrogenation of maleic acid to succinic acid would proceed at acceptable rates at temperatures less than about 130°C. The process of the present invention lessens the corrosive effects of the maleic acid feedstock, while maintaining good conversion of maleic acid to succinic acid in the first hydrogenation step..

Applicant's invention is a two-stage continuous process for the hydrogenation of maleic acid to 1,4-butanediol (BDO), gamma-butyrolactone (GBL) and/or tetrahydrofuran (THF) in a process comprising two hydrogenation zones wherein the temperature of the feedstream comprising maleic acid and the temperature of the first hydrogenation zone are controlled such that the temperature of the maleic acid in the feedstream and the first hydrogenation zone does not exceed about 130°C.

35 USC § 112, First Paragraph Rejection

Claims 1-13 are rejected under 35 U.S.C. 112, first paragraph.

The Examiner states that the specification, while being enabling for hydrogenation catalyst of Group VIII of the Periodic Table does not reasonably provide enablement for any and all catalysts, that the specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected to make and use the invention commensurate in scope with these claims, and that a hydrogenation reaction employing any and all catalysts is not properly supported in the specification.

Applicants respectfully traverse this rejection.

The primary feature of Applicants' invention is the temperature range claimed for the first reaction zone. The invention requires that both the temperature of the feedstream comprising maleic acid and the temperature of the first hydrogenation zone be controlled such that the temperature of the maleic acid in the feedstream and the first hydrogenation zone does not exceed about 130°C. The purpose of this is to reduce corrosion that can occur with a maleic acid feed at higher temperatures.

The disclosure at page 6, line 14, to page 7, line 12, of the Specification describes the type of catalysts suitable for use in the claimed process. It can be seen from this

disclosure that "any and all catalysts" are not taught as useful. This disclosure on pages 6 and 7 of the Specification relating to the catalysts which may be use in practicing the process would enable one skilled in the art to choose a catalyst suitable for use in the claimed process.

35 USC § 112, Second Paragraph Rejection

Claims 1-16 are rejected under 35 U.S.C. 112, second paragraph.

The Examiner states that Claims 1-16 are indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, that the claims recite a series of process steps to produce gamma-butyrolactone, 1, 4-butanediol and /or tetrahydrofuran from hydrogenating maleic acid and hydrogen in the presence of a catalyst, and that it is not clear what conditions have to prevail to produce either gamma-butyrolactone alone or 1,4-butanediol or tetrahydrofuran or a combination of the above. Are all the products being produced in equal amount, and if not what are the ratios or amounts of each product.

Applicants respectfully traverse this rejection.

As stated above, the primary feature of Applicants' invention is the temperature range claimed for the first reaction zone. The temperature of the maleic acid feedstream and the first hydrogenation zone are controlled so that the temperature does not exceed 130°C in order to minimize corrosion caused by maleic acid in the reactor piping and in the reactor.

The disclosure under the heading "The Process" at page 7, line 13 to page 9, line 23 describe the process and states that "The effluent from the second hydrogenation zone, predominately 1,4-butanediol, unreacted hydrogen and water with minor quantities of tetrahydrofuran, gamma-butyrolactone and other by-products."(See page 9, lines 10-12. In addition, at page 9, lines 21-22, the Specification states that "The yields of 1,4-butanediol achieved are about 80 mole percent or greater, typically about 90 mole percent or greater."

Applicants submit that there is nothing indefinite about Claims 1-16. One skilled in the art would know from reading the specification what is being claimed. As stated before, the main point of the invention is to control the temperature in the first reactor to minimize corrosion caused by the maleic acid feed. There is no requirement to claim the specific ratios of 1,4-butaindiol, gamma-butyrolactone, and tetrahydrofuran produced in order for the claims to particularly point out and distinctly claims the subject matter which applicants regards as the invention.

Double Patenting Rejection

Claims 1-16 are rejected under the judicially created doctrine of obviousness-type double patenting over claims 1-13 of Budge et al., U.S. Patent No 5,196,602. The Examiner has written that:

> "Although the conflicting claims are not identical they are not patentably distinct from each other because there are substantial similarities in the instant process thereof claimed in the patent, which has a common inventive entity with the instant application for same uses. Note the hydrogenation of maleic anhydride to produce 1,4-butanediol occurs in two reaction zones. There is also substantial overlap with the remaining process conditions such as temperature in the first stage is between 100° and 350°C, contact time of bet2ween 0.1 minutes and 10.0 minutes.
>
> One of ordinary skill in the art would thus have been motivated to hydrogenate maleic anhydride to produce 1,4-butanediol, gamma-butyrolactone and tetrahydrofuran by manipulating process parameters such as temperature and contact time with the reasonable expectation that the resulting product would maintain high yield."

Applicants respectfully traverse this rejection.

The thrust of Applicants' invention is the temperature range claimed for the first reaction zone. Applicants assert that there is nothing obvious about this claimed temperature range. The instant invention requires that both the temperature of the feedstream comprising maleic acid and the temperature of the first hydrogenation zone be controlled such that the temperature of the maleic acid in the feedstream and the first hydrogenation zone does not exceed about 130°C. This critical feature of Applicants' invention is required in order to minimize corrosion in the reactor feed piping and in the reactor. This discovery greatly benefited the commercial practice of this process by making the commercial process more economical. Neither the lower first hydrogenation zone temperature nor the "corrosion lessening" benefit provided by this temperature are suggested by the teachings of Budge et al.

The Budge et al. patent flows from earlier catalyst related research work relating to the hydrogenation of maleic anhydride to 1,4-butanediol. Specifically, Budge et al. taught and claimed a two stage process for the hydrogenation of maleic anhydride which utilized a different catalyst in each stage and more specifically a ruthenium containing catalysts in the second stage. Budge et al. suggested maleic acid as an alternative to maleic anhydride in

their process; however, no examples in Budge et al. were directed to the hydrogenation of maleic acid.

Since Budge et al. did not work with maleic acid, the corrosive effects of maleic acid were not appreciated by Budge et al. The reaction temperatures taught by Budge et al., at Column 3, lines 49 to 51, illustrate this:

"The reaction temperature for the first stage is typically between about 100°C and about 350°C and preferably about 150°C and about 300°C."

This actually teaches away from the current invention. Additionally, this clearly shows that at the time of the Budge et al. patent, higher first zone temperatures were believed to be preferred. Lastly, there is no teaching or suggestion in Budge et al. as to the need to additionally maintain the temperature of the feedstream to the first hydrogenation zone at a temperature below about 130°C.

Moreover, to the extent there is overlap in the temperature range taught by Applicants for the feedstream and the first hydrogenation zone (i.e. less than about 130°C) and the temperature range taught by Budge et al. for the first hydrogenation stage (i.e. between 100 and 350°C), the instant application is a "species" representing an unobvious and patentable improvement over the early teachings of the Budge et al. genus. This improvement was illustrated in the "Examples" on page 12 of the specification, which compared the extent of corrosion on metal test rods exposed to maleic acid at temperatures of 140°C and above versus the extent of corrosion on metal test rods exposed to maleic acid at temperatures of 130°C and below. The test showed that corrosion on the test rods was virtually eliminated at temperatures of 130°C and below.

Applicants assert that the instant invention requiring "that the temperature of the feedstream comprising maleic acid and the temperature of the first hydrogenation zone be controlled such that the temperature of the maleic acid in the feedstream and the first hydrogenation zone does not exceed about 130°C" is not be obvious to one skilled in the art based upon the teachings of Budge et al. As such, Applicants respectfully assert that the claims of the instant application are patentably distinct over the teachings and claims of Budge et al.

35 U.S.C. § 103 Rejection

Claims 1-16 are rejected under 35 U.S.C. 103(a) as being obvious and unpatentable over Budge et al. (U.S. Patent No. 5,196,602) in view of Bockrath et al. (U.S. Patent No. 6,008,384) Applicants respectfully traverse.

As stated above, the thrust of Applicants' invention is the temperature range claimed for the first reaction zone. The instant invention requires "that the temperature of the feedstream comprising maleic acid and the temperature of the first hydrogenation zone be controlled such that the temperature of the maleic acid in the feedstream and the first hydrogenation zone does not exceed about 130°C." This critical feature of Applicants' invention is required in order to minimize corrosion in the reactor feed piping and the reactor. This discovery greatly benefited the commercial practice of this process by making the commercial process more economical.

The instantly claimed process is not disclosed by Budge et al. At best, Budge et al. teaches a first stage temperature of between 100 and 350°C, with 150 to 300°C being preferred (column 3, lines 49-51). Budge et al. does not teach that feedstock or first reaction zone temperatures be maintained at less than about 130°C. Budge et al. does not teach that there is a "corrosion lessening" benefit to operating at these conditions.

As such, Applicants respectfully assert that Budge et al. does not disclose the instantly claimed process and that the claims of the instant application are patentable over the disclosure and claims of Budge et al.

Essentially, Budge et al. is cited as revealing first stage temperatures in the range of 100 to 350°C (column 3, lines 49-51), and Bockrath is cited as revealing second stage temperatures less than 175°C and preferably 130 to 135°C (column 3, lines 25-26).

Applicants have shown above that their process is not taught or suggested by Budge et al. Specifically, for the reasons set forth above, Applicants' first stage temperature is not rendered obvious by the teachings of Budge et al. As such, the combination of Budge et al. and the cited portions of Bockrath et al. do not suggest Applicants' invention in its entirety and the combination is irrelevant.

Further, with respect to the Bockrath et al. reference, Applicants have submitted with this response a copy of the Declaration under 37 C.F.R. 131 which was filed in the parent application, U. S. Serial No. 09/651,526 filed August 29, 2000, stating that Applicants had conceived and reduced to practice the claimed invention prior to the publication date of Bockrath et al. This Declaration "swears behind" the Bockrath et al. reference and effectively removes the teachings of Bockrath et al. as to second stage temperatures as a reference.

As such, Applicants respectfully assert that Budge et al. in view of Bockrath et al. does not disclose the instantly claimed process and that the claims of the instant application are patentable over this combination.

Bockrath et al.

Applicants wish to call the Examiner's attention to Example 11 of Bockrath et al. Applicants had not been previously aware of the disclosure by Bockrath et al. of the reactor temperatures employed in this Example.

Applicants have submitted with this response a copy of the Declaration under 37 C.F.R. 131 which was filed in the parent application, U. S. Serial No. 09/651,526 filed August 29, 2000, stating that Applicants had conceived and reduced to practice the claimed invention prior to the publication date of Bockrath et al.

Applicants are aware that limited references to U.S. Patent No. 6,008,384 to Bockrath et al. were made in the application. Specifically, Bockrath et al. is referred to in Applicants' specification on page 1, lines 23-26:

"U.S. Patent No. 6,008,384 teaches a two-stage hydrogenation process for the hydrogenation of maleic acid which employs a bimetallic (Ru and Re)-on-carbon catalyst and wherein the effluent of the first-stage is cooled considerably prior to introduction into the second stage."

And on page 1, line 3 to page 2, line 3:

"To hydrogenate maleic acid to 1,4-butanediol, an elevated temperature is required. For example, U.S. Patent No. 6,008,384 teaches that maleic acid is advantageously hydrogenated to 1,4-butanediol at temperatures between 160°C and 250°C."

U.S. Patent No. 6,008,384 is usable against the instant claims only insofar as the disclosure therein is acknowledged as prior art in the present application. In re Hellsund, 474 F.2d 1307, 177 U.S.P.Q. 170 (CCPA 1973).

As the Examiner can see from the above, column 3, lines 16-26 relied upon by the Examiner and Example 11 clearly were not acknowledged by Applicants as prior art in the present application.

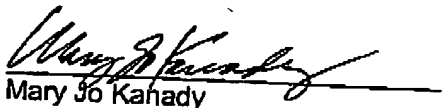
As such, the attached Declaration effectively "swears behind" Bockrath et al. and effectively removes it as a reference (except to the extent acknowledged in the application.)

Application No. 10/645,429

SUMMARY

Applicants have shown their invention to be patentable over the cited references. Applicants respectfully request that the Examiner withdraw the outstanding rejections and forward the application to issuance.

Respectfully submitted,



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